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1855-1930

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1859-1951

BOSTON
DALLAS
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SILICON VALLEY
TWIN CITIES
WASHINGTON, DC

September 8, 2000

Attorney Docket No.: 12203-002001

Box Patent Application
Commissioner for Patents
Washington, DC 20231

Presented for filing is a new original patent application of:

Applicants: ERNIE H. LIN and ADOLF J. GIGER

Title: WIRELESS MODEM

Enclosed are the following papers, including those required to receive a filing date under 37 CFR 1.53(b):

	Pages
Specification	22
Claims	6
Abstract	1
Declaration	[To be Filed at a Later Date]
Drawing(s)	6

Enclosures:

— Postcard.

Basic filing fee	$345
Total claims in excess of 20 times $9	$18
Independent claims in excess of 3 times $39	$39
Fee for multiple dependent claims	$0
Total filing fee:	$402

Under 37 CFR §1.53(f), no filing fee is being paid at this time.

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Samantha Bell
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Samantha Bell
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This application is entitled to Small Entity status; a Small Entity Statement will be filed at a future date.

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Boston, MA 02110-2804

Respectfully submitted,

Paul A. Pysher
Reg. No. 40,780
Enclosures
PAP/dxb
20098575.doc

Attorney's Docket No.: 12203-002001

APPLICATION

FOR

UNITED STATES LETTERS PATENT

TITLE: WIRELESS MODEM

APPLICANTS: ERNIE H. LIN AND ADOLF J. GIGER

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Samantha Bell
Signature

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Attorney Docket No. 12203/002001

WIRELESS MODEM

Background

This invention relates to a wireless modem.

Computers typically connect to networks, such as the Internet, through a "wired" device, such as a modem. Wired, in this context, refers to wired connections, such as telephone lines, Ethernet cable, and the like.

There are limitations associated with the use of wired devices. For example, wired devices have limited portability, since their operation is dependent upon on a wired connection. The installation options for wired devices are also limited, since wired devices require a nearby telephone jack or outlet.

Summary

In general, in one aspect, the invention is a modem that includes a base unit for transmitting a data signal having substantially no nonlinear distortion and a communication card which receives the data signal from the base unit over a wireless medium, and which performs echo canceling on the data signal. This aspect may include one

or more of the following features.

The communication card may include a switch for selecting a type of medium over which to transmit and receive the data signal. The base unit is in communication with a telephone line and receives an original signal from the telephone line. The base unit generates an RF modulated signal based on the original signal. The base unit includes a transmitter for transmitting the data signal and circuitry which receives the original signal from the telephone line and which generates the data signal from the original signal by maintaining a peak voltage excursion of combined original and echo signals within a linear amplification region of the transmitter. The circuitry in the base unit may be an automatic gain control circuit.

The data signal may be transmitted using digital frequency modulation. The data signal may be transmitted using analog frequency modulation. The base unit transmits the data signal over a frequency channel of the wireless medium. The base unit includes circuitry which detects a transmission error in the data signal and which switches the frequency channel in response to the detected

transmission error. The frequency channel may be a radio frequency (RF) channel and the transmission error may be an error rate measurement in the data signal.

In general, in another aspect, the invention is a modem that includes a base unit and a communication card for transmitting data signals to, and receiving data signals from, the base unit. The communication card includes a switch for selecting a type of medium over which to transmit and receive the data signals.

The type of medium may be a wired medium or a wireless medium. Circuitry may be included in the modem, which triggers the switch in response to detecting a wired medium interface to the modem. The circuitry includes a line presence indicator. The switch is triggered to operate the modem in wired mode when the line presence indicator detects the wired medium and the switch is triggered to operate the modem in wireless mode when the line presence indicator does not detect the wired medium.

In general, in another aspect, the invention is a modem that includes a base unit, which transmits a data signal to a modem card over a frequency channel of a wireless medium. The base unit includes circuitry which

detects a transmission error in the data signal and which switches the frequency channel in response to the detected transmission error. This aspect of the invention may include one or more of the following features.

The frequency channel may be a radio frequency (RF) channel and the transmission error comprises an error rate measurement in the data signal. The error rate measurement may be detected based on a parity bit in the data signal. The parity bit may be a least significant bit taken from a sample of the data signal.

In general, in another aspect, the invention is a modem that includes a base unit, which interfaces to a telephone line, and a communication card for transmitting data signals to, and receiving data signals from, the telephone line via the base unit. The base unit includes a hook switch circuit that seizes the telephone line by drawing direct current from a central office battery to provide an indication that the telephone line is ready to transmit data signals. This aspect of the invention may include one or more of the following features.

The communication card may include a switch for selecting a type of medium over which to exchange the data

signals with the base unit. The type of medium may be a wired medium or a wireless medium.

Other features and advantages of the invention will become apparent from the following description, including the claims and drawings.

Description of the Drawings

Fig. 1 is a block diagram of a wireless modem.

Fig. 2 is a block diagram of a base unit used in the wireless modem.

Fig. 3 is a block diagram of a telephone line interface in the base unit.

Fig. 4 is a block diagram of a wireless modem card used in the wireless modem.

Fig. 5 is a block diagram of the modem circuits used in the wireless modem card.

Fig. 6 is a block diagram of an alternative embodiment of the wireless modem, which includes a "wired" option.

Description

Fig. 1 shows a wireless modem 10. Wireless modem 10 includes a base unit 11 and a wireless modem card 12 (or 19). Wireless modem card 12 interfaces to a computer 13. Wireless modem card 12 may be a PCMCIA (Personal Computer Memory Card International Association) or PC card for a laptop computer, a PCI (Peripheral Component Interconnect) card for a desktop personal computer (PC), or another interface for other computing devices.

Base unit 11 connects to the Public Switched Telephone Network (PSTN) through a 2-wire telephone cord 14 plugged into a telephone wall jack 15. Communication (i.e., data exchange) between base unit 11 and wireless modem card 12 is via a radio frequency (RF) link 16.

RF link 16 transmits over the standard three kilohertz wireless telephone channel that uses "voiceband" frequencies, which extend from 0.3 to 3.4 kHz (kilohertz). Thus, modem data signals can be sent over the wireless telephone channel. The range of the RF link may vary, but it is typically several hundred feet or even longer.

As described below, wireless modem 10 can also operate in a "wired" mode. In the wired mode, wireless

modem 10 uses a standard telephone line to mate to telephone wall jack 15. Data is transmitted over the telephone line rather than over RF link 16.

<u>Base Unit</u>

Fig. 2 shows a block diagram of base unit 11. Base unit 11 includes a telephone line interface 20. Telephone line interface 20, which is also referred to as a data access arrangement (DAA), couples base unit 11 to a standard two-wire, twisted pair, telephone line, generally referred to as "tip" and "ring" wires, via cord 14 and jack 15.

Circuitry included in telephone line interface 20 is shown in Fig. 3. This circuitry couples base unit 11 to the telephone line and, thus, to equipment in a central office. The circuitry includes an electronic ring detector 22, overvoltage protection circuitry 23, polarity protection circuitry 24, hook switch circuit 25, and loop DC holding circuit 22.

Electronic ring detector 22 receives, and responds to, a ringing signal transmitted to base unit 11 from the central office. The ringing signal indicates that a

connection is being made from a remote device to the wireless modem. This ringing signal is a high voltage, low frequency signal. A 90 Vrms (root-mean-square voltage), 16 to 60 Hz (hertz) signal is typically used. Zener diodes (not shown) prevent signals smaller than 12 V from triggering electronic ring detector 26.

Overvoltage protection circuitry 23 protects against high voltages that may be induced on the telephone line, e.g., by lightning or other phenomena. Overvoltage protection circuitry 23 is implemented using Zener diodes and varistors in this embodiment.

Polarity protection circuitry 24 protects against improper voltage polarity on the telephone line due, e.g., to an incorrect connection of the lines or to changes in polarity of a battery located at the central office. Polarity protection circuitry 24 is implemented using a four-diode, full-wave rectifier in this embodiment.

Hook switch circuit 25 connects base unit 11 to the telephone line. Hook switch circuit 25 seizes the telephone line by drawing direct current (DC) from the central office battery, thus indicating to the central office that the line has gone off-hook. Off-hook refers to

the state of a telephone connection in which signals may be transmitted and is analogous to a telephone handset going "off-hook". The DC current may vary from 20 to 120 mA depending on the length of the telephone line to the central office. Hook switch circuit 25 may be implemented using a single solid state relay or an opto-coupler.

Loop DC holding circuit 26 maintains the DC current in the telephone line at a relatively constant level, such as 25 mA (milliamperes), independent of the length of the telephone line. Loop DC holding circuit 26 may also provide a line drop indication signal, which indicates whether DC current is flowing in the loop between the "tip" and "ring" of the telephone line. This feature is beneficial if DC current is interrupted due, e.g., to central office problems or the other party going "off-hook". A transformer 28 provides additional isolation from the telephone line for integrated circuits in base unit 11.

Line presence indicator 27, also shown in Fig. 3, is not present in base unit 11. The operation of line presence indicator 27 is described with respect to Fig. 6.

Referring back to Fig. 2, base unit 11 also includes hybrid circuit 30, automatic gain control (AGC) circuit 31,

radio transmitter 32, microprocessor 33, radio receiver 34, duplexer 35, and antenna 36.

Microprocessor 33 controls the functions of base unit 11 through interaction with telephone line interface 20, radio transmitter 32 and radio receiver 34. Microprocessor 33 also sends and receives control signals to and from wireless modem card 12.

Radio transmitter 32 translates a voiceband data signal from telephone line 14 to a modulated RF signal. Radio receiver 34 translates a modulated RF signal to a voiceband data signal. Radio transmitter 32 and radio receiver 34, which operate on different frequencies, are connected to common antenna 36 using duplexer 35. RF signals are transmitted and received to/from wireless modem card 12 over antenna 36.

The RF signals may be modulated by radio transmitter 32 using a variety of techniques, ranging from analog FM (frequency modulation) to digital FM, such as frequency shift keying (FSK) and spread spectrum techniques.

If digital FM modulation (FSK) is used to modulate an RF signal, radio transmitter 32, which includes the following circuitry, operates as follows. The voiceband

data signal is first digitized using an analog-to-digital (A/D) converter. This signal is then scrambled and applied to a modulator, in this case, an FM deviator, whose output frequency is translated to a final RF frequency using mixers and local oscillators. Local oscillator signals in both the radio transmitter and receiver are normally generated using frequency synthesizers. The frequencies of these signals can be tuned to a desired RF channel at the instruction of microprocessor 33.

One example of an RF modulation method that may be used with wireless modem 10 is described in U.S. Patent No. 5,297,203 (Rose, et al.), which is incorporated by reference into this application.

The modulation method described in Rose, et al. uses FSK modulation and a channel bandwidth of 100 kHz. There are 20 RF channels available, using the frequency band 905.6-907.5 MHz for transmission in one direction (e.g., to wireless modem card 12), and the frequency band 925.5-927.4 MHz for transmission in the other direction (e.g., from wireless modem card 12). The analog data signal is digitized using Adaptive Delta Modulation (ADM), resulting in a bitrate of approximately 48 kb/s (kilobits-per-

second). Using these techniques, the resulting digital signal has a relatively low quantizing noise, leading to high quality data transmission.

The data signal is transmitted using a linear and low noise RF transmission channel to reduce bit errors. If transmission errors are detected, wireless modem 10 will automatically reduce the rate of data transmission from, e.g., 56 kb/s to 33 kb/s or even lower.

If analog FM modulation is used to modulate the RF signal, the voiceband data signal is directly applied to an FM deviator in radio transmitter 32. Analog FM RF transmission provides a stable channel having a baseband gain that is relatively unaffected by variable RF signal levels. Analog FM RF transmission also has good linearity, no quantizing noise, and is relatively immune to overload environments (often referred to as soft overload). A soft overload characteristic is a useful feature in case of echo overload, which is an accepted phenomenon in wireless phones but which may cause limitations in modem data transmission, as explained below.

Hybrid circuit 30 switches modem 10 between 2-wire operation and 4-wire operation. Hybrid circuit 30 may be

implemented using transformers or resistive hybrids in conjunction with OpAmps. The function of hybrid circuit 30 is to separate two signals flowing in opposite directions in the two-wire telephone line 14 into separate signals #1 and #2 available at two terminals. Since hybrid circuit 30 is a bridge circuit, perfect separation can only be achieved if the impedances making up the bridge are matched.

In practice, mismatched impedances give rise to an average 11 dB (decibels) echo with a 3 dB standard deviation. In normal telephone service, this echo simply adds to the deliberately generated sidetone energy. In telephone communications, sidetone energy is necessary so that the speaker can hear his own voice and thus determine how loudly to speak. For modem operation, however, sidetone energy or reflections from the central office are detrimental. Significant elimination of the unbalanced signal is preferred for modems to operate in full duplex mode, i.e., to transmit and receive simultaneously on the same frequency over the same two wires. Modem 10 performs this function as described below.

Signal echoes at hybrid circuit terminal #1, resulting from imperfect hybrid isolation, may be only 8 dB (11 dB average minus 3 dB for standard deviation) below an outgoing data signal 100 at hybrid circuit terminal #2. This echo adds directly to an incoming signal, which, for illustrative purposes, may have a level that is 14 dB below the outgoing signal. In this example, therefore, the echo will be 6 dB stronger, or twice the amplitude of the desired incoming signal. When the incoming signal is transmitted to wireless modem card 12, the RF channel may then be overloaded by the composite signal 101.

The overload results in nonlinear distortions to the combined signal, which cannot be corrected by an echo canceller in wireless modem card 12, since the echo canceller is a linear circuit. Accordingly, AGC circuit 31 is included in base unit 11 to provide a way of reducing the overload of radio transmitter 32. A peak amplitude detector in AGC circuit 31 adjusts the peak amplitude of the composite signal 101 so that it is constant and within the linear amplification region of radio transmitter 32. This eliminates nonlinear distortions in the original data signal. Echoes will vary from user to user and perhaps

even over time. AGC circuit 31 also ensures that these variations stay within the linear range of the transmitter automatically.

Since the original data signal is now within the linear range of the transmitter, the data signal that is transmitted over RF link 16 to the wireless modem card 12 contains substantially no nonlinear distortion. A standard linear echo canceller in the wireless modem card 12 may therefore be used to cancel the echo. This is done, according to well-known techniques, by generating a replica of the echo from the transmitted signal and canceling the echo using the replica. Descriptions of echo cancellers that may be used in modem 10 are found in U.S. Patents Nos. 4,813,073, 4,835,765, 4,970,715, and 5,587,998. As noted above, the standard echo canceling circuits described in these patents may be used to cancel the echo because the AGC circuit in the base unit keeps the nonlinear distortion output from the base unit to a minimum. A level control circuit, included in a standard echo canceller, can also accommodate voltage variations in the voiceband data signal.

AGC circuits are well known in the field of radio communications and can be implemented by many off-the-shelf devices available on the open market. The details of the circuits are therefore not described here.

AGC circuit 31 is also beneficial if RF transmission is via digital modulation, since the amplitude control achieved by AGC circuit 31 centers the signal in the operating range of an A/D converter (not shown) and thus reduces quantizing noise.

In case of interference from other nearby wireless modems or cordless phones, the channel frequency of the wireless modem may be automatically changed to a clear frequency. The decision to change the channel frequency preferably is based on an error rate measurement in the RF channel, under control of the microprocessor 33. One acceptable method that could be used for error detection, if digital RF transmission is used, includes adding a parity bit to every 48 regular bits and using the parity bit to detect errors in the data signal. The parity bit could be the least significant bit taken from an 8-bit PCM (pulse-code modulated) sample once every 6 samples. If analog RF transmission is used, an extra bitstream could be

transmitted in an audio sub-band between 100 and 200 Hz and the errors again measured using parity bits.

Security features may also be provided on base unit 11. For example, to prevent unauthorized over-the-air access of base unit 11, a security code may be used. There may be from 65,000 to one million different codes (also called "keys") available, from which one will be randomly selected by the user.

Another security feature that may be used in digital RF transmission is scrambling of the bitstream. A fixed scrambling code or more sophisticated encryption may be used to scramble the bitstream.

Wireless Modem Card

Fig. 4 shows a block diagram of wireless modem card 12. Wireless modem card 12 includes a wireless modem interface 40 and modem circuits 41. Modem circuits 41, shown in Fig. 5, include a coder/decoder (codec) 42, a digital signal processor (DSP) 43, a controller 44 and its associated memory, and a computer interface 45.

Codec 42 receives analog voice-band data signals from wireless modem interface 40 (over RF link 16) and receives

a data signal from DSP 43. Codec 42 includes an A/D converter 46 for converting an incoming data signal (from base unit 11) from analog to digital form, and a D/A converter 47 for converting an outgoing data signal (a signal going to base unit 12) from digital to analog form.

DSP 43 performs quadrature amplitude demodulation (QAM) and echo canceling on incoming data signals, and QAM modulation of the outgoing signal. DSP 43 also generates and detects DTMF (dual tone multi-frequency) touch-tone dialing signals. The touch-tone dialing signals are used to connect to a remote network/network device. QAM routines running in DSP 43 use up to 1024 QAM states. Echo canceling routines running in DSP 43 include a 128 tap delay line having tap weights set by a training sequence that is performed before data transfer begins.

Controller 44 performs control functions required by wireless modem 10. These may include facsimile transmit and receive functions. For example, at the request of computer 13, controller 44 initiates a call to a remote computer by sending an off-hook command via hook switch circuit 54 to hook switch 25 in base unit 11. Controller 44 receives and recognizes a dial tone, and generates DTMF

touch-tone signals to dial the call. Controller 44 answers an incoming call by receiving and recognizing a ring indication from ring detector 22 in base unit 11 via microprocessor 53 and, in response, initiating an off-hook operation. Another function of controller 44 is to terminate a call either at the request of computer 13 or in response to a remote party breaking connection (the line drop indicator) by sending an on-hook signal via hook switch circuit 54 to hook switch 25 in base unit 11.

Computer interface 45 couples modem circuitry 41 to computer 13. Data is transferred between computer 13 and wireless modem card 12 over computer interface 45. Computer interface 45 is a standard PCMCIA connection for portable computers and a PCI connection for desktop PCs, although other connections may be used.

Referring back to Fig. 4, wireless modem interface 40 includes an antenna 37, a duplexer 50, a radio receiver 51, a radio transmitter 52, a microprocessor 53, and a hook switch circuit 54. The operation of these circuits is similar to the operation of the corresponding circuits described above with respect to Fig. 2. That is, the circuitry is used to exchange data with base unit 11, such

that when wireless modem card 12 transmits data, base unit 11 receives the data, and vice versa.

Wireless modem card 12 communicates with base unit 11 over RF link 16. Wireless modem card 12 receives "ring" and "line drop" indication signals from base unit 11, and sends a "hook switch control" signal back to base unit 11 (Fig. 2). The ring indication signal is sent to modem circuits 41. From there, the ring indication signal is transmitted to computer 13, where it indicates an incoming facsimile transmission or operation of a computer from a remote location, such as a home computer from an office. The hook switch control signal is generated by computer 13 and sent to controller 44. The hook switch control signal is typically a voltage that lasts for the duration of a call to indicate that a call is in progress.

Wired Option

Wireless modem 10 can also be equipped with circuitry for operation as a wired modem. An embodiment of a wireless modem 10 with this circuitry is shown in Fig. 6.

The embodiment of Fig. 6 incorporates standard modem circuitry, including telephone line interface 20 and a

hybrid circuit 55, both of which are similar in structure and function to corresponding circuits described above. A multiple switch 56 selects either the wired or the wireless modes of operation. This switch, which is implemented electronically, is triggered automatically when the telephone wire is plugged into, or removed from, a wall jack or other outlet.

Switch control circuitry 57 detects the state of the telephone wire connection and triggers switch 56 accordingly. More specifically, a line presence indicator 27 (Figures 3 and 6) in the telephone line interface 20 senses the central office battery voltage available at the wall jack and outputs a logic signal 28. Logic signal 28 triggers switch 56 to switch automatically between the wireless and wired modes of operation. Specifically, the switch is triggered to operate the modem in wired mode when the line presence indicator 27 detects the wired medium and the switch is triggered to operate the modem in wireless mode when the line presence indicator 27 does not detect the wired medium.

In this embodiment, line presence indicator is implemented using a voltage sensor, such as an opto

isolator or the like. Line presence indicator generates logic signal 28 in response to detecting a wired medium interface to the modem.

Wireless modem 10 is not limited to use with the hardware/software configuration of Figs. 1 to 6; it may find applicability in any computing or processing environment. The circuitry in wireless modem 10 may be implemented in hardware (e.g., one or more discrete components, ASICs {Application-Specific Integrated Circuit} and/or FPGAs {Field Programmable Gate Array}), software, or a combination of hardware and software.

Wireless modem 10 is also not limited to transmitting data over the RF frequency bands described above, or to the specific modulation and encoding techniques described herein. Techniques and/or transmission methods other than those described above may be used.

Other embodiments not described herein are also within the scope of the following claims.

What is claimed is:

1. A modem comprising:

a base unit for transmitting a data signal having substantially no nonlinear distortion; and

a communication card which receives the data signal from the base unit over a wireless medium, and which performs echo canceling on the data signal.

2. The modem of claim 1, wherein the base unit is in communication with a telephone line and receives an original signal from the telephone line, the base unit generating an RF modulated signal based on the original signal.

3. The modem of claim 2, wherein the base unit comprises:

a transmitter for transmitting the data signal; and

circuitry which receives the original signal from the telephone line and which generates the data signal from the original signal by maintaining a peak voltage excursion of combined original and echo signals within a linear amplification region of the transmitter.

4. The modem of claim 3, wherein the circuitry comprises an automatic gain control circuit.

5. The modem of claim 1, wherein the data signal is transmitted using digital frequency modulation.

6. The modem of claim 1, wherein the data signal is transmitted using analog frequency modulation.

7. The modem of claim 1, wherein the base unit transmits the data signal over a frequency channel of the wireless medium, the base unit comprising circuitry which detects a transmission error in the data signal and which switches the frequency channel in response to the detected transmission error.

8. The modem of claim 7, wherein the frequency channel comprises a radio frequency (RF) channel and the transmission error comprises an error rate measurement in the data signal.

9. The modem of claim 1, wherein the communication card includes a switch for selecting a type of medium over which to transmit and receive the data signal.

10. A modem comprising:

a base unit; and

a communication card for transmitting data signals to, and receiving data signals from, the base unit, the communication card including a switch for selecting a type of medium over which to transmit and receive the data signals.

11. The modem of claim 10, wherein the type of medium comprises a wired medium.

12. The modem of claim 10, wherein the type of medium comprises a wireless medium.

13. The modem of claim 10, further comprising circuitry which triggers the switch in response to detecting a wired medium interface to the modem.

14. The modem of claim 13, wherein the circuitry comprises a line presence indicator; and

wherein the switch is triggered to operate the modem in wired mode when the line presence indicator detects the wired medium and the switch is triggered to operate the modem in wireless mode when the line presence indicator does not detect the wired medium.

15. A modem comprising:

a base unit which transmits a data signal to a modem card over a frequency channel of a wireless medium, the base unit including circuitry which detects a transmission error in the data signal and which switches the frequency channel in response to the detected transmission error.

16. The modem of claim 15, wherein the frequency channel comprises a radio frequency (RF) channel and the transmission error comprises an error rate measurement in the data signal.

17. The modem of claim 16, wherein the error rate measurement is detected based on a parity bit in the data

signal.

18. The modem of claim 17, wherein the parity bit comprises a least significant bit taken from a sample of the data signal.

19. A modem comprising:

a base unit which interfaces to a telephone line, the base unit including a hook switch circuit that seizes the telephone line by drawing direct current from a central office battery to provide an indication that the telephone line is ready to transmit data signals; and

a communication card for transmitting data signals to, and receiving data signals from, the telephone line via the base unit.

20. The modem of claim 19, wherein the communication card comprises a switch for selecting a type of medium over which to exchange the data signals with the base unit.

21. The modem of claim 20, wherein the type of medium comprises a wired medium.

22. The modem of claim 20, wherein the type of medium comprises a wireless medium.

Attorney Docket No. 12203/002001

WIRELESS MODEM

Abstract

A modem includes a base unit for transmitting a data signal having substantially no nonlinear distortion, and a communication card which receives the data signal from the base unit over a wireless medium and which performs echo canceling on the data signal. The base unit is in communication with a telephone line and receives an original signal from the telephone line. The base unit generates an RF modulated signal based on the original signal. The base unit includes a transmitter for transmitting the data signal. Circuitry in the base unit receives the original signal from the telephone line and generates the data signal from the original signal by maintaining a peak voltage excursion of combined original and echo signals within a linear amplification region of the transmitter.

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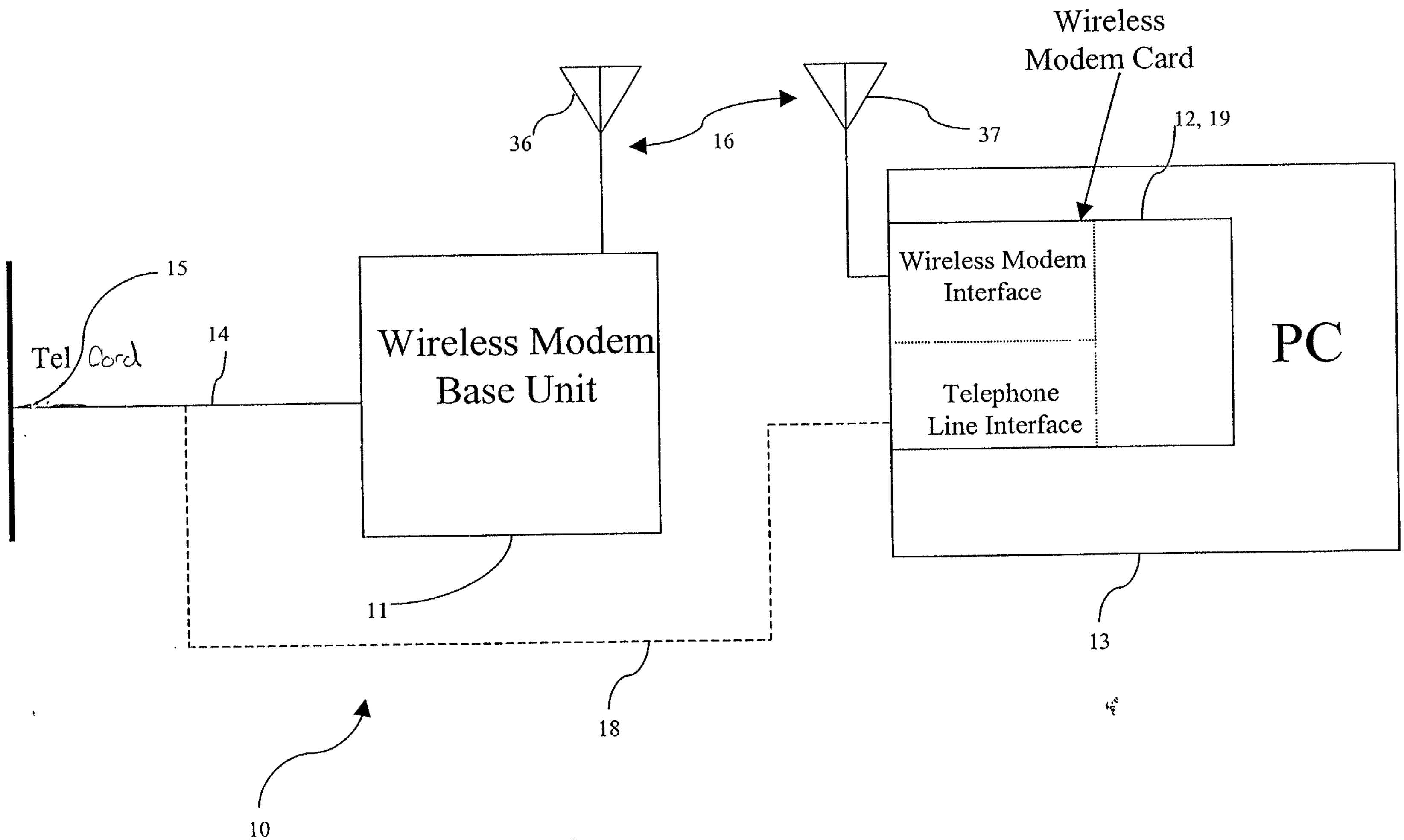
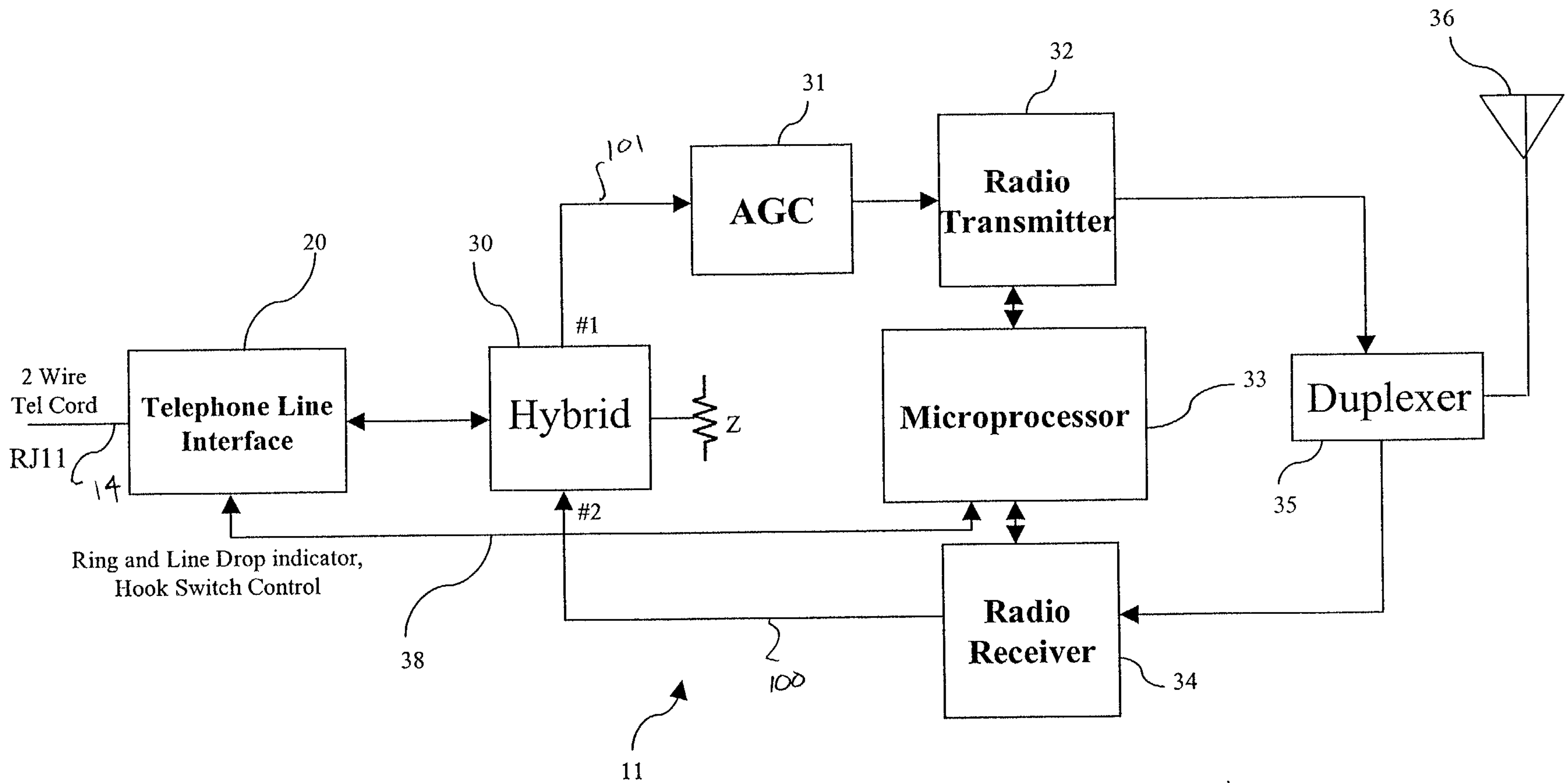

Wireless
Modem Card
12, 19
36
16
37
15
Tel Cord
14
Wireless Modem
Base Unit
Wireless Modem
Interface
Telephone
Line Interface
PC
11
13
18
10

Figure 1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32
31
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AGC
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20
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Telephone Line Interface
Hybrid
Z
Microprocessor
33
Duplexer
RJ11
14
35
#2
Ring and Line Drop indicator, Hook Switch Control
Radio Receiver
38
100
34
11

Figure 2

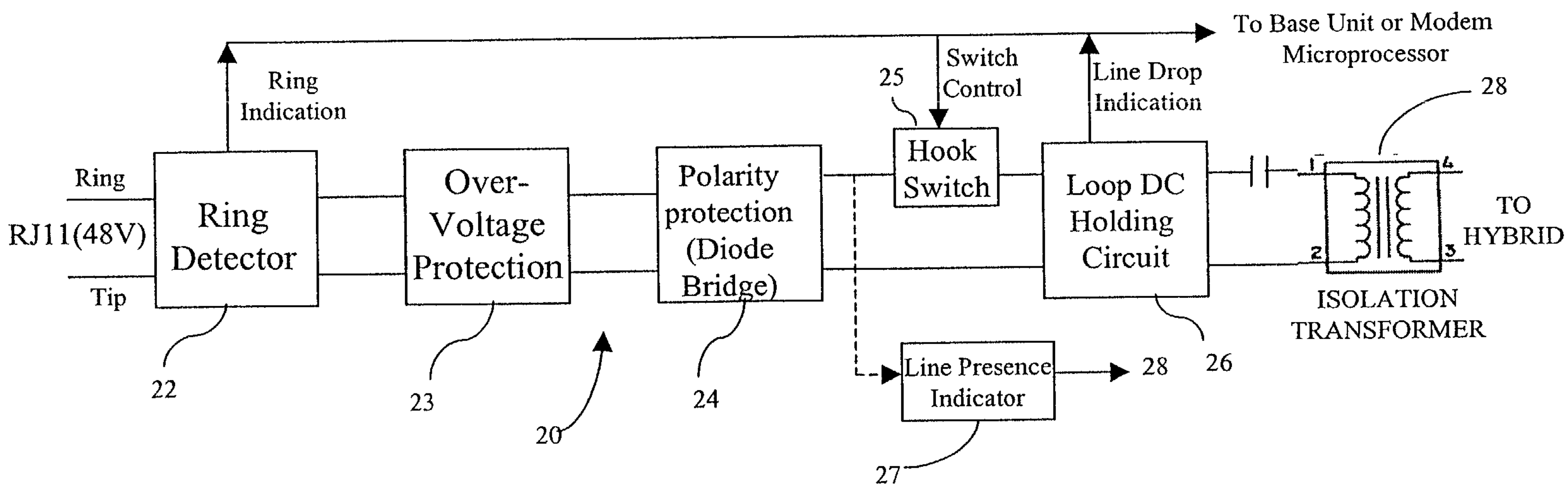
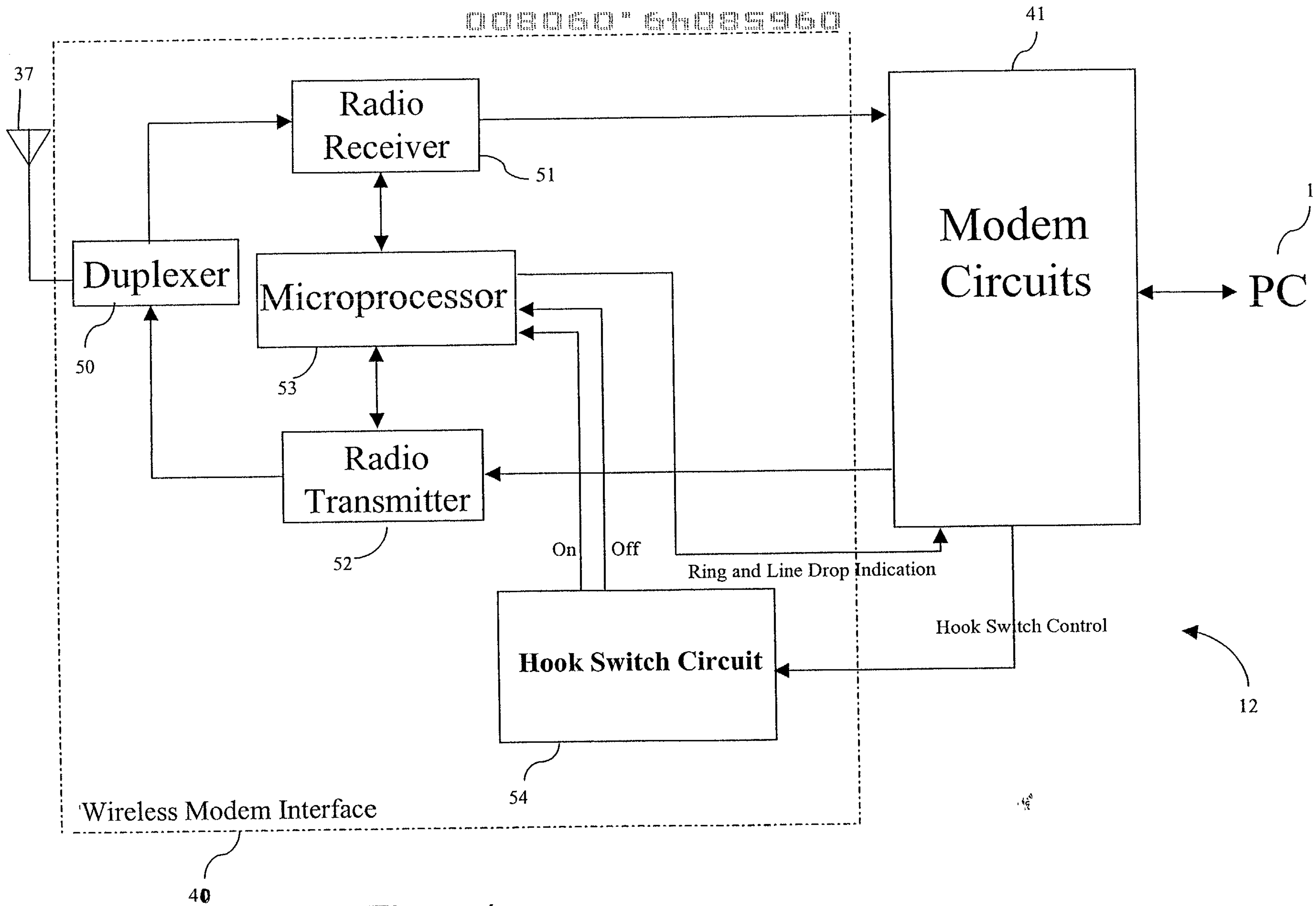
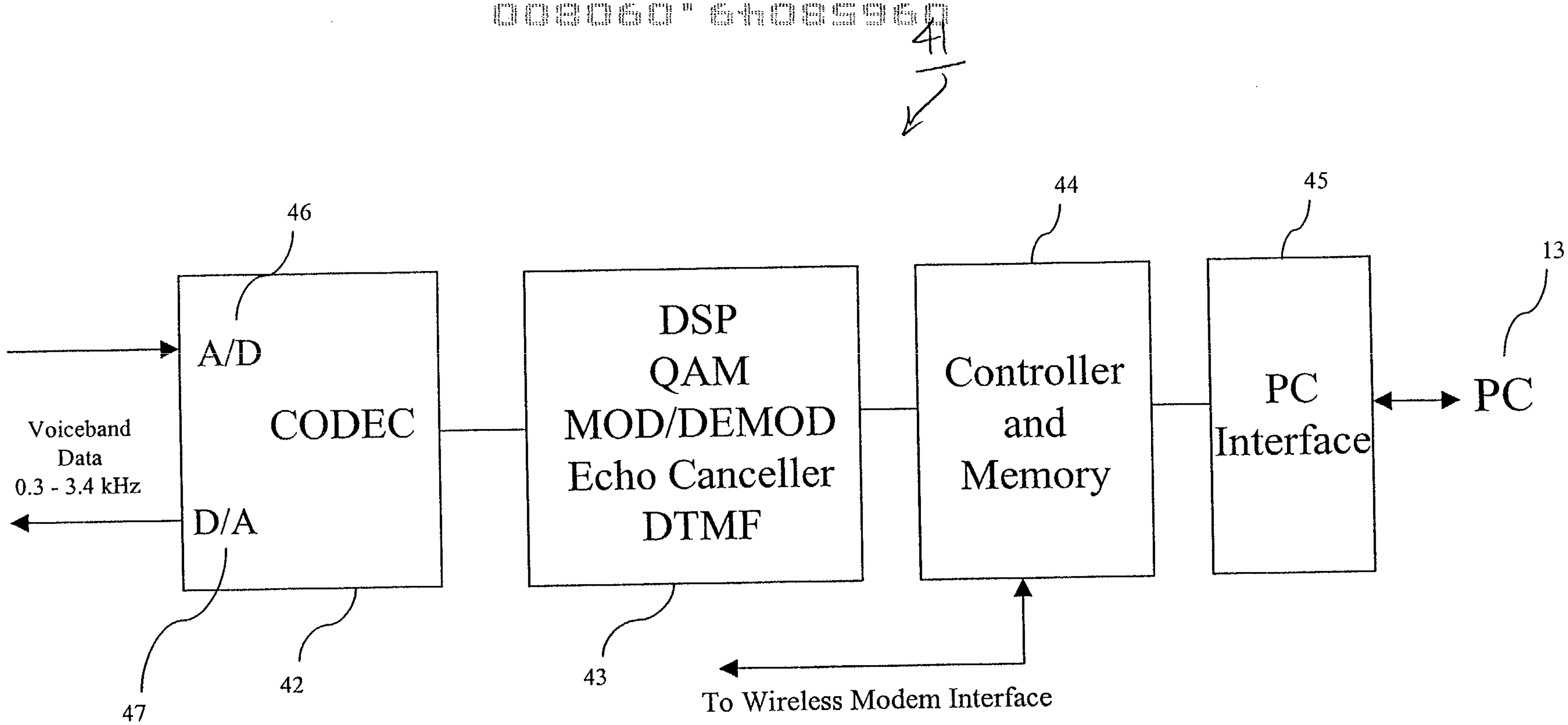

To Base Unit or Modem Microprocessor
Ring Indication
Switch Control
Line Drop Indication
Ring
RJ11(48V)
Tip
Ring Detector
Over-Voltage Protection
Polarity protection (Diode Bridge)
Hook Switch
Loop DC Holding Circuit
Line Presence Indicator
TO HYBRID
ISOLATION TRANSFORMER
1
2
3
4
20
22
23
24
25
26
27
28
28

Figure 3



37
Radio Receiver
51
Duplexer
50
Microprocessor
53
Radio Transmitter
52
On
Off
Ring and Line Drop Indication
Hook Switch Circuit
54
Wireless Modem Interface
40
41
Modem Circuits
13
PC
Hook Switch Control
12

Figure 4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44
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0.3 - 3.4 kHz
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To Wireless Modem Interface

Figure 5

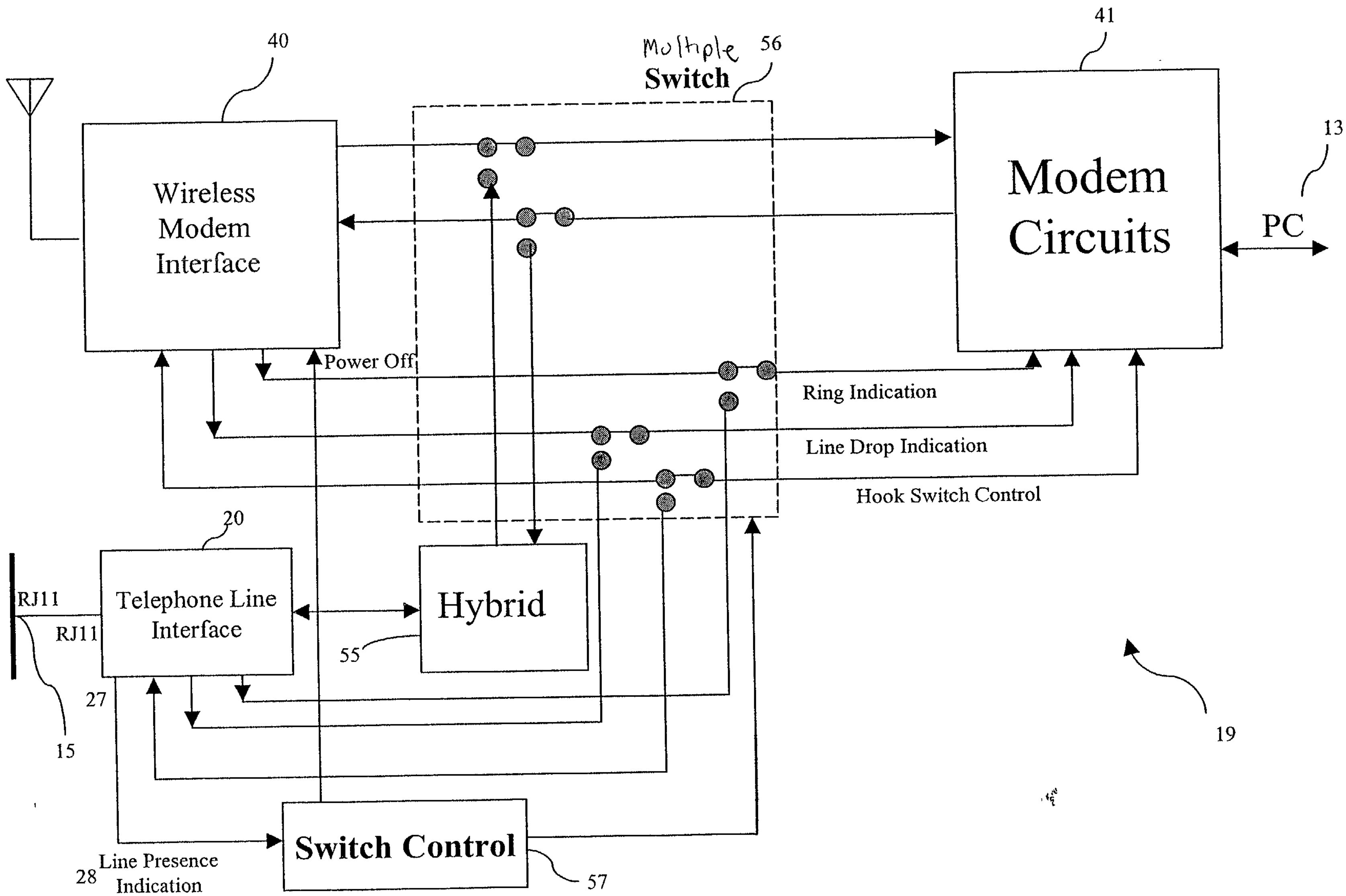
40
41
Multiple
56
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Figure 6